

What is claimed is:

1. A wafer heating assembly comprising:  
a holding device having a plurality of recesses, the holding device having a wafer support configured to support a wafer;  
a plurality of heating units, wherein at least one heating unit comprises:  
a tube having a carbon wire heater comprising a carbon fiber bundle and sealed within the tube, each tube being mounted in a recess in the holding device, and  
a connecting terminal coupled to opposing ends of the carbon wire heater; and  
a mounting assembly coupled to the holding device and configured to mount the wafer heating assembly to a processing chamber.
2. The wafer heating assembly as claimed in claim 1, wherein at least one of said heating units comprises a substantially straight tube mounted in a substantially straight recess in the holding device.
3. The wafer heating assembly as claimed in claim 1, wherein at least one of said heating units comprises a curved tube mounted in a curved recess in the holding device.
4. The wafer heating assembly as claimed in claim 1, wherein at least one of said heating units comprises a circular tube mounted in a circular recess in the holding device.
5. The wafer heating assembly as claimed in claim 1, wherein at least one of said heating units comprises a square tube mounted in a square recess in the holding device.
6. The wafer heating assembly as claimed in claim 1, wherein at least one of said heating units comprises a rectangular tube mounted in a rectangular recess in the holding device.

7. The wafer heating assembly as claimed in claim 1, wherein at least one of said heating units comprises an elliptical tube mounted in an elliptical recess in the holding device.

8. The wafer heating assembly as claimed in claim 1, wherein at least one of said heating units comprises a U-shaped tube mounted in a recess in the holding device.

9. The wafer heating assembly as claimed in claim 8, wherein the recess comprises a U-shape.

10. The wafer heating assembly as claimed in claim 1, wherein at least one of said heating units comprises a plurality of segments, each segment comprising a substantially straight tube having a carbon wire heater comprising a carbon fiber bundle sealed therein, and a connecting terminal coupled to each end of each carbon wire heater, each substantially straight tube being mounted in a substantially straight recess in the holding device.

11. The wafer heating assembly as claimed in claim 1, wherein at least one of said heating units comprises a plurality of segments, each segment comprising a substantially straight tube having a carbon wire heater comprising a carbon fiber bundle sealed therein, and a connecting terminal coupled to each end of each carbon wire heater, the plurality of segments being mounted in a square recess in the holding device.

12. The wafer heating assembly as claimed in claim 1, wherein at least one of said heating units comprises a plurality of segments, each segment comprising a substantially straight tube having a carbon wire heater comprising a carbon fiber bundle sealed therein, and a connecting terminal coupled to each end of each carbon wire heater, the plurality of segments being mounted in a rectangular recess in the holding device.

13. The wafer heating assembly as claimed in claim 1, wherein at least one of said heating units comprises a plurality of segments, each segment comprising a curved tube having a carbon wire heater comprising a carbon fiber bundle sealed therein, and a connecting terminal coupled to each end of each carbon wire heater, the plurality of segments being mounted in a curved recess in the holding device.

14. The wafer heating assembly as claimed in claim 13, wherein the curved recess comprises a circular shape.

15. The wafer heating assembly as claimed in claim 13, wherein the curved recess comprises an elliptical shape.

16. The wafer heating assembly as claimed in claim 1, further comprising  
a thermal barrier coupled to the holding device; and  
a cooling unit coupled to the thermal barrier.

17. The wafer heating assembly as claimed in claim 1, further comprising a temperature sensor coupled to the holding device.

18. The wafer heating assembly as claimed in claim 1, wherein the heating unit further comprises transitional elements coupled to respective ends of the tube, and a sealing terminal portion coupled to the transitional elements, each connecting terminal being coupled to at least one sealing terminal portion.

19. The wafer heating assembly as claimed in claim 18, wherein the tube and the transitional elements are formed from a single piece of material.

20. The wafer heating assembly as claimed in claim 19, wherein the single piece of material comprises a quartz glass tube.

21. The wafer heating assembly as claimed in claim 18, wherein the tube is formed from a first piece of material and the transitional elements are formed from a second piece of material.

22. The wafer heating assembly as claimed in claim 21, wherein at least one of the first piece of material or the second piece of material or both the first and second pieces of material comprises a quartz glass tube.

23. The wafer heating assembly as claimed in claim 18, wherein the sealing terminal portion comprises means for sealing end portions of the transitional elements.

24. The wafer heating assembly as claimed in claim 18, wherein the sealing terminal portion comprises means for sealing end portions of the tube.

25. The wafer heating assembly as claimed in claim 18, wherein the heating unit further comprises endpoint elements coupled to opposite ends of the carbon wire heater, the endpoint elements comprising compressed wire carbon members, and the carbon wire heater being buried in the compressed wire carbon members.

26. The wafer heating assembly as claimed in claim 1, wherein the carbon wire heater comprises a carbon wire, the carbon wire comprising at least one bundle of carbon fibers, each bundle comprising at least 300 carbon fibers each having a diameter of between 5 and 15 micrometers.

27. The wafer heating assembly as claimed in claim 26, wherein the carbon wire further comprises surface fluffing.

28. The wafer heating assembly as claimed in claim 26, wherein ash content in the carbon fiber is less than 10 ppm.

29. The wafer heating assembly as claimed in claim 1, further comprising a cover coupled to the holding device.

30. The wafer heating assembly as claimed in claim 29, wherein the wafer support comprises a plurality of raised portions on the cover.

31. The wafer heating assembly as claimed in claim 30, wherein at least one raised portion comprises a temperature sensor.

32. The wafer heating assembly as claimed in claim 1, wherein the wafer support comprises a plurality of raised portions on the holding device.

33. The wafer heating assembly as claimed in claim 32, wherein at least one raised portion comprises a temperature sensor.

34. The wafer heating assembly as claimed in claim 1, wherein the wafer support comprises a quartz wafer holder having at least three support points.

35. The wafer heating assembly as claimed in claim 1, further comprising:

- an additional heating unit comprising:

- an additional tube having a carbon wire heater comprising a carbon fiber bundle and sealed within the additional tube, and

- a connecting terminal coupled to opposing ends of the carbon wire heater of the additional heating unit; and

- an additional mounting assembly coupled to the additional holding device and configured to position the additional heating unit above the wafer support.

36. The wafer heating assembly as claimed in claim 1, further comprising:

- an additional heating unit comprising:

an additional tube having a carbon wire heater comprising a carbon fiber bundle and sealed within the additional tube, and  
a connecting terminal coupled to opposing ends of the carbon wire heater of the additional heating unit; and  
an additional mounting assembly coupled to the additional holding device and configured to position the additional heating unit substantially around the wafer support.

37. The wafer heating assembly as claimed in claim 1, further comprising:

an additional heating unit comprising:  
an additional tube having a carbon wire heater comprising a carbon fiber bundle and sealed within the additional tube, and  
a connecting terminal coupled to opposing ends of the carbon wire heater of the additional heating unit;  
an additional holding device coupled to the additional tube; and  
an additional mounting assembly coupled to the additional holding device and configured to position the additional heating unit above the wafer support.

38. The wafer heating assembly as claimed in claim 1, further comprising:

an additional heating unit comprising:  
an additional tube having a carbon wire heater comprising a carbon fiber bundle and sealed within the additional tube, and a connecting terminal coupled to opposing ends of the carbon wire heater of the additional heating unit;  
an additional holding device coupled to the additional tube; and  
an additional mounting assembly coupled to the additional holding device and configured to position the additional heating unit substantially around the wafer support.

39. The wafer heating assembly as claimed in claim 1, further comprising:

- a second holding device having a plurality of second recesses, the second holding device having a second wafer support configured to support a second wafer;

- a second plurality of heating units, wherein at least one of the second plurality of heating units comprises:

- a tube having a carbon wire heater comprising a carbon fiber bundle and sealed within the tube, each tube being mounted in a recess in the second holding device, and

- a connecting terminal coupled to opposing ends of the carbon wire heater; and

- a second mounting assembly coupled to the second holding device and configured to mount the second holding device to the processing chamber.

40. A method of processing a substrate, the method comprising:  
positioning the substrate on a substrate holder in a processing chamber, wherein the substrate holder comprises a plurality of heating units, each heating unit comprising:

- a tube and a carbon wire heater having a carbon fiber bundle and sealed within the tube, each tube being mounted in a recess in the substrate holder, and

- a connecting terminal coupled to opposing ends of the carbon wire heater; and

- performing a Rapid Thermal Process on the substrate, wherein a DC supply is coupled to each connecting terminal and DC power is rapidly applied to the carbon wire heater.

41. A wafer heating assembly comprising:

- means for supporting a semiconductor wafer;

- means for independently heating different regions of said semiconductor wafer; and

means, coupled to the means for holding, for mounting the wafer heating assembly to a processing chamber.

42. A method of processing a substrate comprising independently controlling multiple carbon wire heater zones with independent temperature sensors to provide a multiple zone, single wafer heater system with rapid response to each independent zone, said control being tunable to minimize wafer warpage from rapid thermal changes.

43. A method of processing a substrate comprising using carbon wire heater elements as a substrate support to minimize thermal mass and permit thermal changes rapid enough for processing control by increments of rapid thermal cycles.

44. A method of processing a substrate comprising using carbon wire heater elements on opposing sides of the substrate, said heater elements having multiple independent heater zones and rapid thermal response from either heater element and one or more heater zones.

45. The wafer heating assembly as claimed in claim 1, further comprising alternate cooling loops corresponding to the carbon wire heater elements to increase the speed of the thermal response, the cooling loops configured to flow gas for cooling or other, thermally compatible coolant material or fluids.